(2) Remarks

Dear Examiner,

Responsive to the outstanding Office Action dated 04/26/2005, we have:

1. Amended claim 1 by limiting the shape of the mode transformer. The claim was objected to as being similar to prior art disclosed in Application Publication 2003/0053756 to Lam in light of Application Publication 2003/0044118 to Zhou. In the field of planar waveguide optics, it is important to keep at the fore, the fact that the exact shape and index distribution of a device is paramount to how that device functions. Both in the present application, and in Lam, the mode transformer collects the light from a high confinement small spot size waveguide, and matches it to an optical fiber spot size (or works in the reverse direction). For instance, in paragraph [**0001**] of Lam, it is stated that "There is a great need to couple efficiently the light between a semiconductor edge emitting waveguide device and a single mode optical fiber". The same paragraph mentions the small mode size of the semiconductor waveguide in comparison to the larger optical fiber mode. Figure 7 of Lam shows the preferred embodiment of the mode transformer. This figure clearly shows the fiber spot (dashed circle) only coupling to the bottom untapered waveguide. Further, and significantly, it shows that the upper waveguide has a tapered section that laterally tapers down in the direction of the optical fiber. That is, the pointed end of the taper faces the fiber. In paragraph [**0008**] of Lam, the mode of the semiconductor waveguide (that is, the small mode), is launched into the second waveguide (that is, the guide having the taper), at the end of that waveguide opposite to the pointed end of the taper. In contrast, referring to Figure 3 in our application, the small mode waveguide is the bottom waveguide that has no taper. In addition, the taper in our second waveguide points towards the small spot waveguide, as opposed to away from it as in Lam. Because the details of the structure of Lam's mode transformer are different than ours, and because the placement of our small mode waveguide is different than that of Lam's small mode waveguide, the principle of operation between the two mode transformers must be different. Based on the teaching of Lam, the high efficiency coupling results of our mode transformer is an unexpected result. In order to clarify our unique shape, we have amended

claim 1 so as to distinguish the taper direction from that of Lam's. To further clarify that our mode transformer works on the principle of mode evolution, as opposed to directional coupling such as in Lam, we have added in our claim to the effect that our two waveguides form a composite waveguide structure.

2. Deleted the word "substantially" in claim 2. The word "substantially" was objected to as being a relative term, and therefore, the choice of index values in the Lam application were said to also be substantially the same. In planar waveguide optics, if one value is substantially the same as a second value, it implies that the resultant effect, such as the operation of a device, is similar. In Lam, the refractive index values of 1.475 and 1.56, are in fact markedly different, rather than substantially the same. If they were substantially the same (as in "having the same effect"), Lam would not need two different waveguides, with these two different refractive index values, to achieve a mode transforming device connecting an optical fiber to a small spot size semiconductor waveguide. Lam teaches that the smaller refractive index value is used to construct a waveguide that is better matched to the optical fiber side of the device, while the larger refractive index is used to construct a waveguide that is better matched to the semiconductor waveguide side of the device. In our device we do not rely on two different refractive index values. In light of the teachings of Lam, our results based on waveguides having the same index to match both the large and small spot waveguides, are unexpected. Therefore, our mode transformer is principally different than Lam's. In order to clarify our claim 2, we have amended it by removing the word "substantially".

3. Canceled limiting method claims 3, 4 and 5. Dependent claim 1 is a device claim, while claims 3-5 are limiting method claims.

4. Kept original claim 6. It is argued that Zhou and Lam disclose providing and input fiber, and matching the widths of the waveguides to the optical fiber. As claim 6 now refers to an amended claim 1, we submit dependent claim 6 unchanged.

5. Kept original claim 7. Claim 7 was objected to based on the mode transformer of Lam, wherein Lam discloses the thickness of both the first and second waveguides as being substantially the same as the fiber input mode. Figure 7 in Lam shows that the fiber is coupled to the bottom waveguide, and not to both waveguides. It is the bottom waveguide in Lam that is substantially the same as the fiber. The optical field collected by the bottom waveguide is subsequently coupled to the top waveguide. In our application, the input fiber spot is matched to the sum of the first and second waveguide. Light is collected simultaneously by the first and second waveguides. If our mode transformer were based on mode coupling as in Lam's, the power captured from the fiber in the first guide would subsequently couple to the second guide, and due to reciprocity, power captured from the fiber in the second waveguide would subsequently couple to the first guide. Therefore, not all of the power would end up in a single guide at the end of the tapered section, and the transformer would be inefficient. The fact that our mode transformer is highly efficient, (as evidenced by its now reduction to practice), is an unexpected result, in light of Lam's configuration of collecting all light from the fiber into only one waveguide. Our invention therefore, is patentable over Lam's.

6. Amended claim 8 by limiting it through combining it with original claims 11 and 12. Although Lam and Zhou show a two waveguide mode transformer, neither discuss a method of forming the second waveguide on top of the first by a means of depositing a cladding over the first waveguide and subsequently a means for planarizing this cladding before depositing the second waveguide. Lam only discusses using a spin on glass as the cladding over the first waveguide. Spin on glasses, as well as polymers, have severe reliability issues, and are not commonly used in commercial optical telecom products. Our application discloses a method to achieve planarization through standard semiconductor processes including chemical mechanical polishing, and multiple dep-and-etch process. The multiple dep-and-etch process is a known planarization process in the semiconductor fabrication art, and differs from a single etch used to form a waveguide, and which the examiner had objected to as being the same.

7. Canceled claim 9.

8. Kept original claim 10. Claim 10 now depends on amended claim 8, and we submit that taken together, this defines patentable art.

9. Canceled claim 11.

10. Canceled claim 12.

11. Canceled claim 13.

12. Canceled claim 14.

13. Added new claim 15 which recites that matching the fundamental mode of the composite waveguide of the mode transformer to that of the input fiber of claim 6 is the preferred construct.

(3) Conditional Declaration filed under section 1.131

We submit that the amended claims define patentability over the prior art. Should objectionable similarities continue to exist between our amended application and the prior art applications of Lam 10/006,752 and Zhou 10/083,674, we request that the examiner take into account our affidavit of prior invention pursuant to section 1.131.

Inventor's credentials

Dr. Little obtained a B.A.Sc. in Electrical Engineering in 1984, and a PhD in Electrical Engineering in 1994, both from the University of Waterloo, Canada. He held a Post Doctoral position, and subsequently a Research Associate position, at the Massachusetts Institute of Technology (MIT) for five years. He has held a Research Professor position and the University of Maryland, as well as positions at Nortel Networks and Fujitsu. He has consulted for a number fiber optic companies. In 2000, he founded Little Optics Inc, and served as its President and Chief Technology Officer. The company has since raised $25M in venture capital. Little Optics Inc pioneered high index contrast photonic circuits. Dr. Little has published over 75 articles in peer reviewed journals and holds several patents in the field.

Place of Invention

The work performed in conceiving, analyzing, and reducing to practice of this invention was performed in the USA.

The following attached pages (pages 10-13) from my lab notebook detail this invention as occurring before the priority dates of the cited prior art references (Appl. No. 10/006,752 to Lam et. al. and Appl. No. 10/083,674 to Zhou et. al.)

I declare that the devices and products of this application were conceived by me on the dates listed in the lab notes.

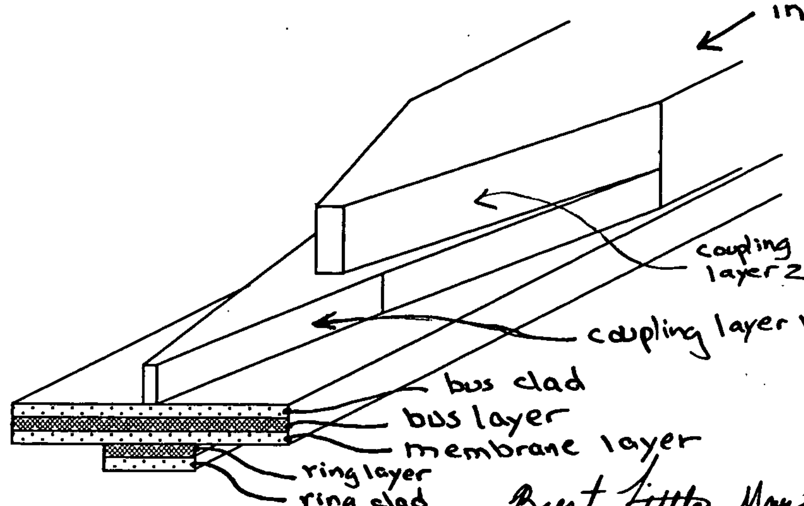
Brent Little

Page 11 is a copy of page 41 of Brent Little's "Little Optics Lab Notebook #2" showing an embodiment of the mode transformer of the present application. In the schematic drawn, there is a bus waveguide which is the high confinement (HC) waveguide of the present application. On top of the HC waveguide there are one or more additional waveguides that have tapers that taper down from the input fiber side. This concept is recorded and dated on May 25, 2000.

Page 12 is a copy of page 12 of Brent Little's "Little Optics Lab Notebook #3" showing another embodiment of the mode transformer of the present application. In the schematic drawn, there is a bus waveguide which is the high confinement (HC) waveguide of the present application. Underneath the HC waveguide there is one additional waveguide layer that has a taper that tapers down from the input fiber side. This concept is recorded and dated August 22, 2000.

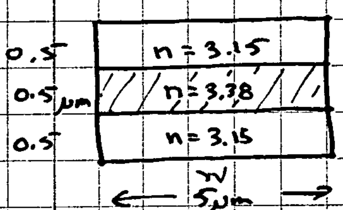
Page 13 is a copy of page 17 of Brent Little's "Little Optics Lab Notebook #3" showing another embodiment of the mode transformer of the present application. In the schematic drawn, there is a bus waveguide which is the high confinement (HC) waveguide of the present application. Underneath the HC waveguide there is one additional waveguide layer that has a taper that tapers down from the input fiber side. There is also a Beam Propagation Method (BPM) simulation showing the high efficiency of coupling from a fiber into the bus waveguide of the device. This concept is recoded and dated September 5, 2000.

Method to couple fiber modes to HC modes May 25/00

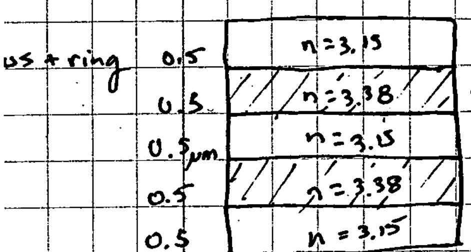


Brent Little May 25/00

Some effective indexs at $\lambda = 1.55\,\mu m$

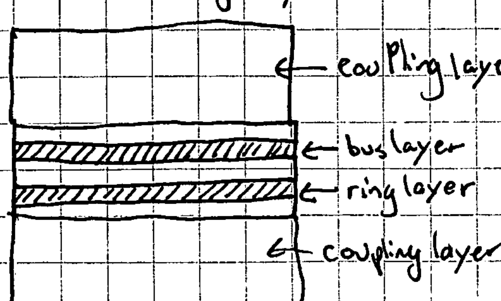


	W=5	W=10	W=1µm	W=0.6µm
N_{eff_x} =	3.2732	3.27587	3.19012	3.04287
N_{eff_y} =	3.2634	3.26591	3.19885	3.1086



	W=5µm	W=10	W=1µm	W=0.6µm
N_{eff_x}	3.28295	3.2856	3.2002	3.05358
N_{eff_y}	3.27493	3.27744	3.2106	3.12096

OR Put coupling layers 1 and 2 on both sides of the chip:



taper both coupling layers on ring & bus side

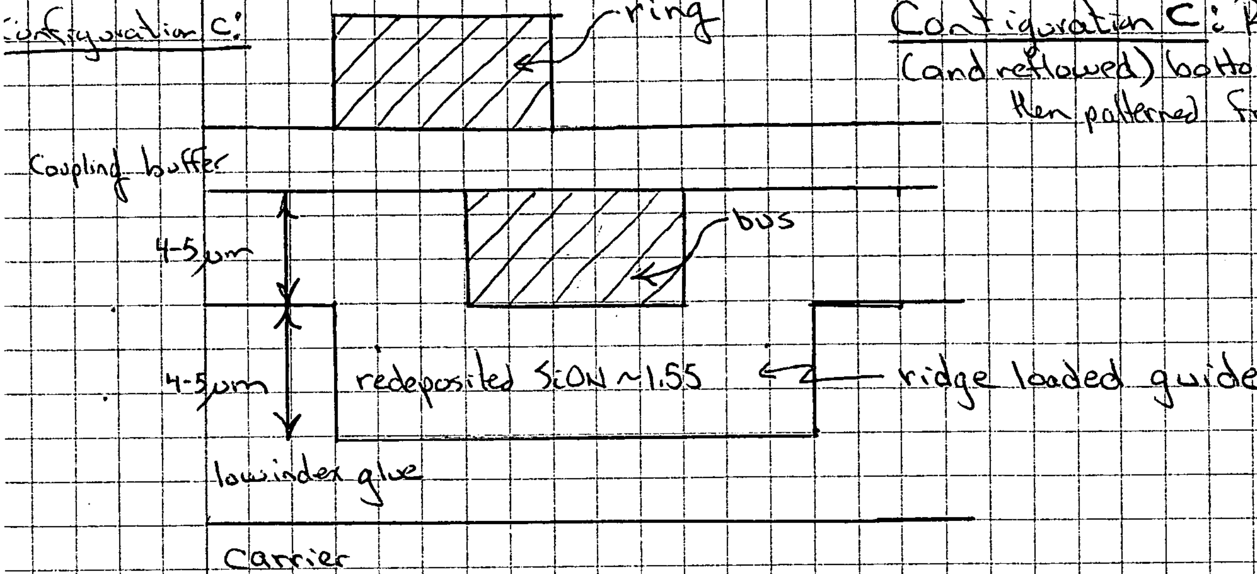
Then taper ring layer down

Brent Little May 25/00
page 8/14

Aug 22, 00 Vertically Coupled resonator configurations

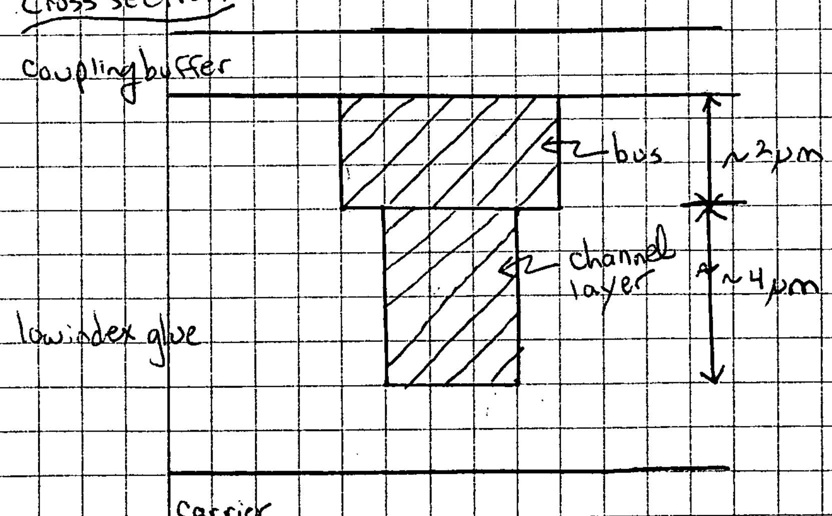
Configuration C:

Configuration C: Redeposited (and reflowed) bottom buffer, then patterned from bottom to top

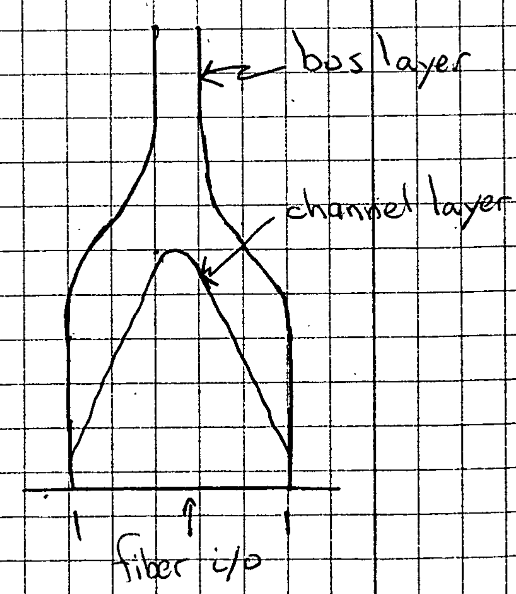


Configuration D: Double etch on bus guide, Can make channel guide arbitrarily wide by about 6µm deep

cross section



top-down



Brad Little Aug 22, 00

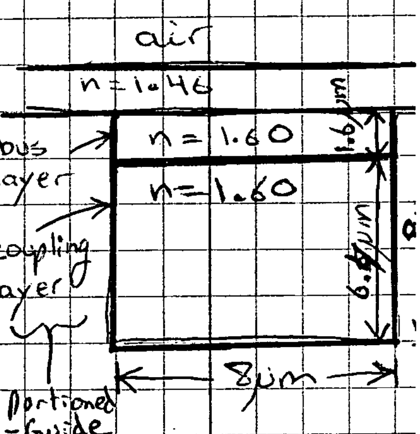
8/22/00

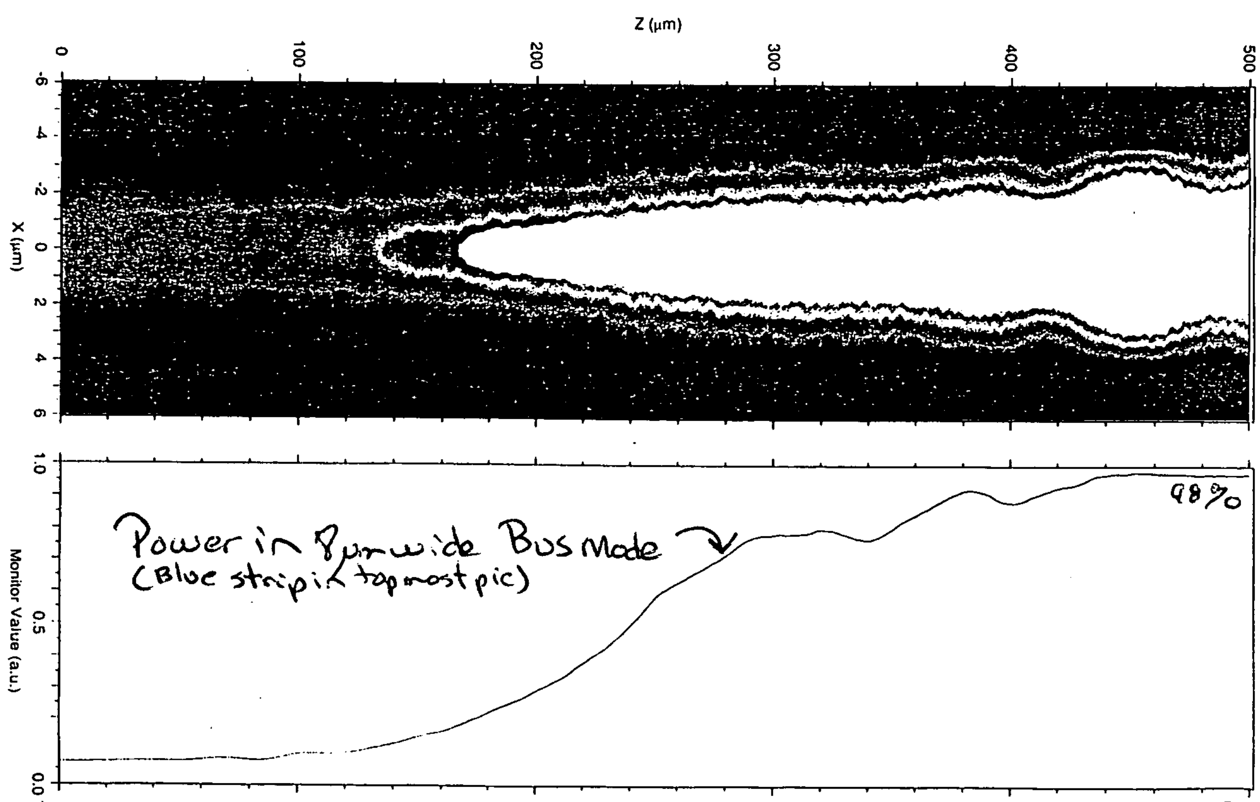
Partioned-Guide i/o coupler

Sept 5, 200

Top down

Cross-section





9/5/00

Sept 5/00

Conditional Request for Constructive Assistance

Applicant has amended the specification and claims of this application so that they are proper, definite and define novel structure which is also unobvious. If, for any reason this application is not believed to be in full condition for allowance, applicant respectfully requests the constructive assistance and suggestions of the Examiner pursuant to M.P.E.P. section 2173.02 and section 707.07(j) in order that the undersigned can place this application in allowable condition as soon as possible and without the need for further proceedings.

Very Respectively,

Brent Little

Brent E. Little

Applicant Pro Se